M1. (a) 3800

> *allow **1** mark for 2000*
>
> *allow **1** mark for 1800*
>
> *if neither of above scored, allow correct substitution for **1** mark (800 × 2.5) + (600 × 3)*
>
> *if moments have been calculated incorrectly, allow 1 mark for adding their two moment values correctly*

3

newton metres **or** Nm

> *do **not** allow nm **or** NM*

1

(b) as the girl increases her distance (from the pivot) the clockwise moment increases

1

(F must increase) as the anticlockwise moment must increase

1

so (the anticlockwise moment) is equalled / balanced by the clockwise moment
or
so resultant / overall moment (on the board) is zero

> *accept to balance / equal the moments*
>
> *to balance the board is insufficient*

1

[7]

M2. (a) (i) **X** at the centre of the lifebelt

*measuring from the centre of **X**, allow 2 mm tolerance in any direction*

1

(ii) any **two** from:

if X is on vertical line below the hanger (but not at centre) can gain the first point only

below the point of suspension

*accept '(vertically) below **Y**'*

at the centre (of the lifebelt)

accept 'in the middle'

(because) the lifebelt / it is symmetrical

***or** (because) the mass / weight is evenly distributed*

2

(b) Nm **or** newton metre(s)

accept Newton metre(s)
*do **not** accept any ambiguity in the symbol ie NM, nM or nm*

1

750

(moment) = force $\times$ (perpendicular) distance (between line of action and pivot)
***or** (moment) = 500 $\times$ 1.5 gains **1** mark*

2

(c) Quality of written communication:

*for **2** of the underlined terms used in the correct context*

1

any **three** connected points from:

low(er) centre of mass / gravity

***or** centre of mass / gravity will be close(r) to the wheels / axle / ground*

(more) stable

***or** less unstable*

less likely to fall over

accept 'less likely to overturn'

*do **not** accept 'will not fall over'*

the <u>turning effect / moment</u> (of the weight of case) is less
> ***or** so less effort is needed to hold the case*
> *ignore references to pulling the case*

so the pull on her arm is less

3

[10]

M3. (a) 810 000

allow 45 000 × 18 for 1 mark

2

newton-metres / Nm

1

(b) any **three** from:

ignore references to force throughout

- their weight / mass can be altered / adjusted

- so that the crane remains stable

  allow does not topple

- so that the (total) clockwise moment equals the (total) anticlockwise moment

  *do **not** allow just 'moments are equal'*

- because not all containers are the same weight / mass

  *do **not** allow 'not all containers are the same size / volume'*

- because not all containers will be / need to move the same distance (from the crane)

- to keep the centre of mass (of the upper crane and container) in/ above the base of the tower

- so that the crane remains in equilibrium/balanced

3

[6]

M4. (a)　point at which its mass (seems to) act **or** point at which gravity (seems to) act

> *accept ... its weight acts*
>
> *accept correct statements if the intent is clear e.g.. .. if suspended, the centre of gravity will be directly under the point of suspension*
>
> *e.g.... (if the object is symmetrical), the centre of gravity is on the **or** an axis (of symmetry)*
>
> *do **not** credit just 'it is a point'*

1

(b)　*The answer to this question requires good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme*

> *maximum of **4** marks if ideas not well expressed*

any **five** from:

clamp (steel) rod (horizontally)

> ***no** marks if method quite unworkable*

hang plastic / sheet by rod through (one) hole

hang plumb line from rod

mark ends of plumb line on the sheet and
use the ruler to draw a straight line

repeat with other hole

centre of mass is where the lines cross

check by balancing at this point

> *maximum of **3** marks if no 'repeat with other hole'*

5

(c)　(i)　　(turning) effect **or** moment
　　　　force
　　　　distance

> *all three correct*

accept weight
accept length

1

(ii)   17.6
        *allow 44 x 0.4 **or** 0.4 x 44 for **1** mark*

2

Nm **or** newton metre(s)
        *do **not** accept N/m **or** N/cm*
        *1760 Ncm gains all **3** marks*

1

[10]

M5. (a)   (i)   turning effect

             accept turning force

             accept force X distance

             (accept symbols only if correctly defined)

             *do **not** accept newtons X metres*

     1

   (ii)   stop apparatus falling over

             accept holds the stand in place

             accept make it safer / stable

             references to balanced / equilibrium are insufficient

     1

   (iii)   as *X* increases *y* increases

     1

             in same proportion / ratios

             allow both marks for they are <u>directly</u> proportional

             or

             a specific example eg doubling y, doubles X

             allow both marks for a correct answer giving figures

             eg they increase in the ratio of 1 to 7

             *allow for **1** mark positive correlation*

     1

   (iv)   the centre of mass of the ruler is at the axis of rotation

     1

(b)   108

            *allow **1** mark for correct substitution ie 240 x 0.45*

     2

        newton metres / Nm

            symbols must be correct

            for full credit the unit must be consistent with the numerical answer

     1

           [8]

M6. (a) moment

*or torque do **not** credit 'leverage'*

1

(b) 4 (2)

either 0.20 × 20 (1) or allow '400' (1)

2

(c) use a longer spanner

or increases the perpendicular distance / length

or 'fit a pipe over the (end of the) spanner (to lengthen it)'

note 'lever' refers to 'spanner'
note <u>change</u> the . . . (0)
ignore references to wider / larger nut

1

use a greater force / pull

either order

1

[5]

M7. (a)　any **two** from:

- inversely proportional

- as the load gets biggerthe (maximum safe) distance gets less
   allow 'as the mass increases the distance decreases'
   accept an unspecified response e.g. 'big load at a short distance' for (1)

- load × distance = 60 (kNm)

2

(b)　yes, because 30 × 2 = 60 (2)
   accept for (1) a correct but insufficiently explained response e.g. 'yes because it's safe'
   accept for (2) a correct response which is sufficiently explained
   e.g. 'yes, because 60 (kNm) at 1 metre is safe and 30 (kNm) is half the load at twice the distance
   *do **not** accept 'no' and do not accept just 'yes'*
   *do **not** accept 'yes, because 30 is between 24 and 40 and 2 is between 2.5 and 1.5'*
   *do **not** accept 'the crane/ cable may break' or other dangers*

2

(c)　the crane may/will topple over/fall <u>over/forward</u>

1

(d)　results of experiments on this mobile crane
   accept any unambiguous indication

1

[6]